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## **17<sup>th</sup> Annual NJDOT Research Showcase**

# **Current Status and Future Role of Unmanned Aircraft Systems and Sensors in Linear Infrastructure Integrity Management & Operations**

**David W. Yoel**  
**Founder and CEO**



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# UAS - What we Do

Medium Altitude  
Long Endurance  
Beyond Line-of-Sight  
Fixed Wing UAS



Integrate  
Operate &  
Disseminate



In the National  
Airspace  
in  
Energy  
and  
Emergency  
Management  
Applications

RS-16



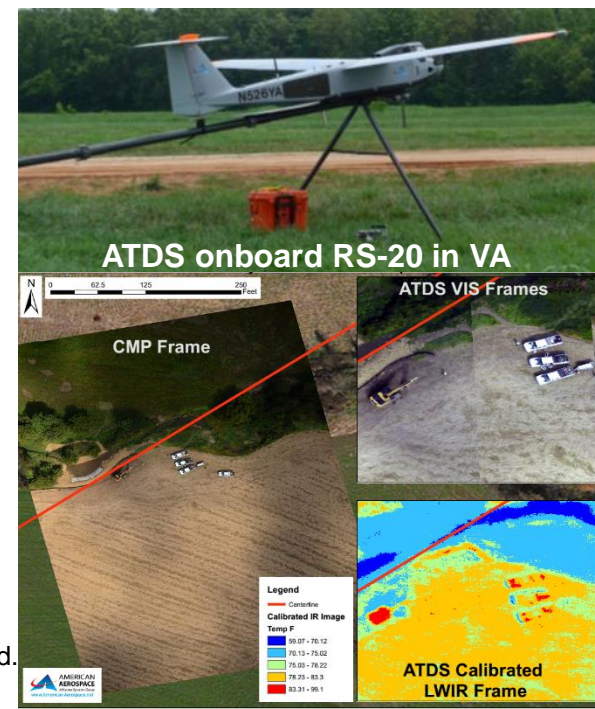
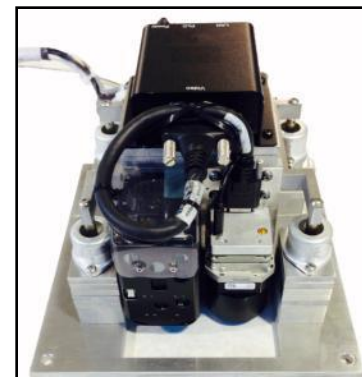
- Flight Services
- Mission Systems



# AATI Relevant Background

- Flying BVLOS in the NAS since 2010
  - 1<sup>st</sup> BVLOS flight on linear corridor in US history in 2015
- Created the RS-16 and RS-20 UAS™
  - 12+ hour UAS
    - Designed for civilian applications
    - Not repurposed military aircraft
  - AATI has completed over 200 safe, legal and successful flights in civilian airspace
- Our public entity customers have 1,250 square miles of approved airspace across the country for RS-16 & RS-20 UAS
- Working with Energy Sector, Emergency Management and Universities for 5+ years
  - Linear Infrastructure Inspection
  - Environmental, Coastal and Ocean Sciences
  - Wildland Fire and Hurricane Response

Airborne  
Threat  
Detection  
System  
(ATDS)



# Classes of Unmanned Aircraft of Interest



	<b>“333 Class”</b>	<b>BLOS UAS</b>
Payload Capacity	2 to 25 lbs	50-150 lbs
Endurance	~1 hour	10+ hours
Range	½ mile	1,000 miles
Ceiling	8,000 ft	24,000’



# Linear Infrastructure Applications

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- Pipeline Integrity Management
- Power Line Inspection
- Railways
- Roads & Bridges
- Navigable Waterways
- Threat Detection
- Emergency Response
- Facilities Management
  - Inspections
  - Inventory
  - Construction Management
  - Security

# Pipeline Integrity Management



## • Threat Detection

- Machinery
- Gas Leak (Methane, Alkanes...)
- Liquid Leak
- Geotechnical Threats

## • Emergency Response

- Hurricanes, floods, tornados, ice storms, fires, HazMat...

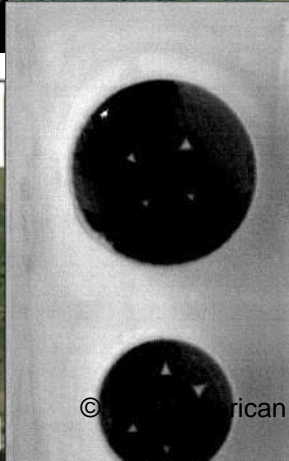
## • Vegetation Management

## • Encroachment Studies

## • Population Studies

## • Facilities Management

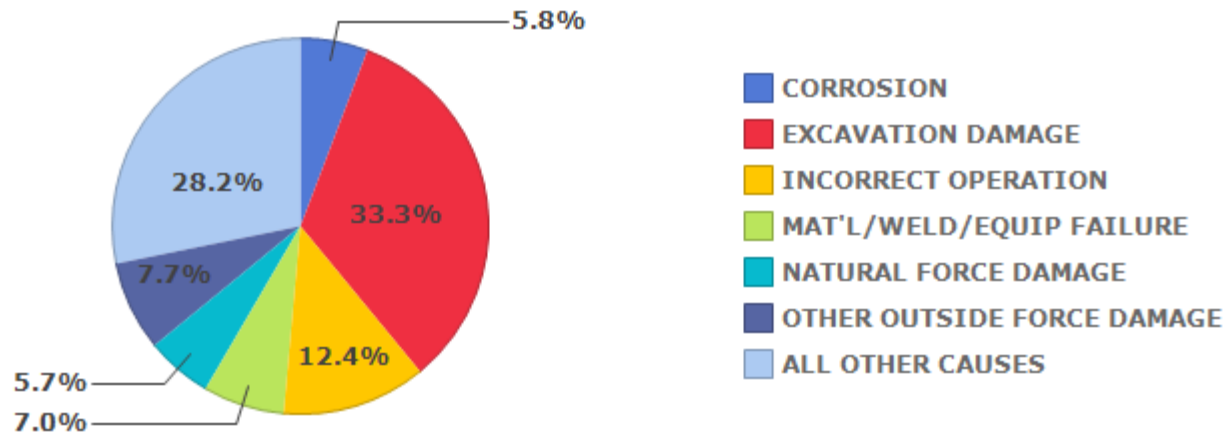
- Inspections
- Inventory
- Construction Management
- Security & Emergency Response





# Motivation for Automated Monitoring of Pipelines

**Serious Incident Cause Breakdown**  
National, All Pipeline Systems, 1993-2012



Source: PHMSA Significant Incidents Files, Nov 1, 2013

## DOT PHMSA Reported Incidents

National All Pipeline Systems: Serious Incident Details: 1993-2012					
Cause	Number	%	Fatalities	Injuries	Property Damage
EXCAVATION DAMAGE					
OPERATOR/CONTRACTOR	31	3.10%	1	49	\$3,434,945
THIRD PARTY	293	29.70%	141	447	\$95,305,653
PREVIOUS DAMAGE DUE TO EXCAVATION	1	0.10%	0	4	\$182,500
UNSPECIFIED	3	0.30%	4	5	\$1,055,000
Sub Total	328	33.20%	146	505	\$99,978,098

[http://primis.phmsa.dot.gov/comm/reports/safety/SerPSIDet\\_1993\\_2012\\_US.html](http://primis.phmsa.dot.gov/comm/reports/safety/SerPSIDet_1993_2012_US.html) | Report generated on: 11/05/13



# Motivation - ROW Monitoring Using BLOS UAS

- UAS show great promise as a new aerial patrol tool for linear infrastructure
  - Enabling technology for significant new applications that cannot be performed by manned aircraft
- **Safety: ability to patrol linear infrastructure eliminate risk to pilot and crews**
  - ***Including night ops and safe emergency response***
- Far Greater Endurance (12+ hours)
- Higher Precision Flight Profiles
- Multi-sensor capability
- Effective field communications
- Cost of Operation
  - Promise of far lower Cost of Operation as
    - Regulatory framework is established
    - Civil/commercial market accelerates
    - Technology matures
    - Operations mature

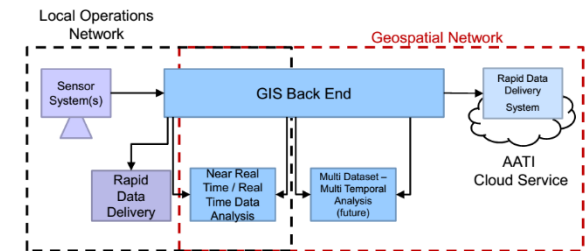
Parameter	Units	Cessna 172	RS-16 UAS
Endurance	Hours	4	12 to 16
Range	Miles	400	600+
Fuel	Gallons	52	1.5
Pilots	No.	1	0.33

***100X lower fuel burn than standard  
patrol aircraft carrying the same  
payload***

# The Recon System UAS

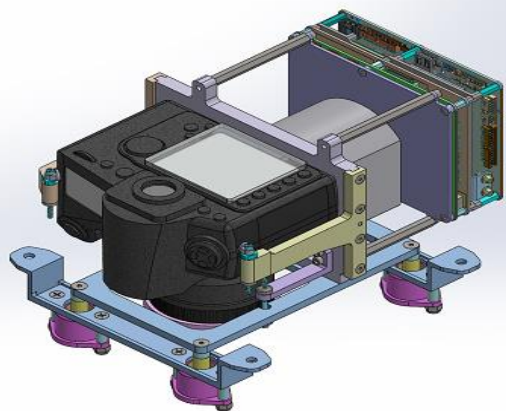
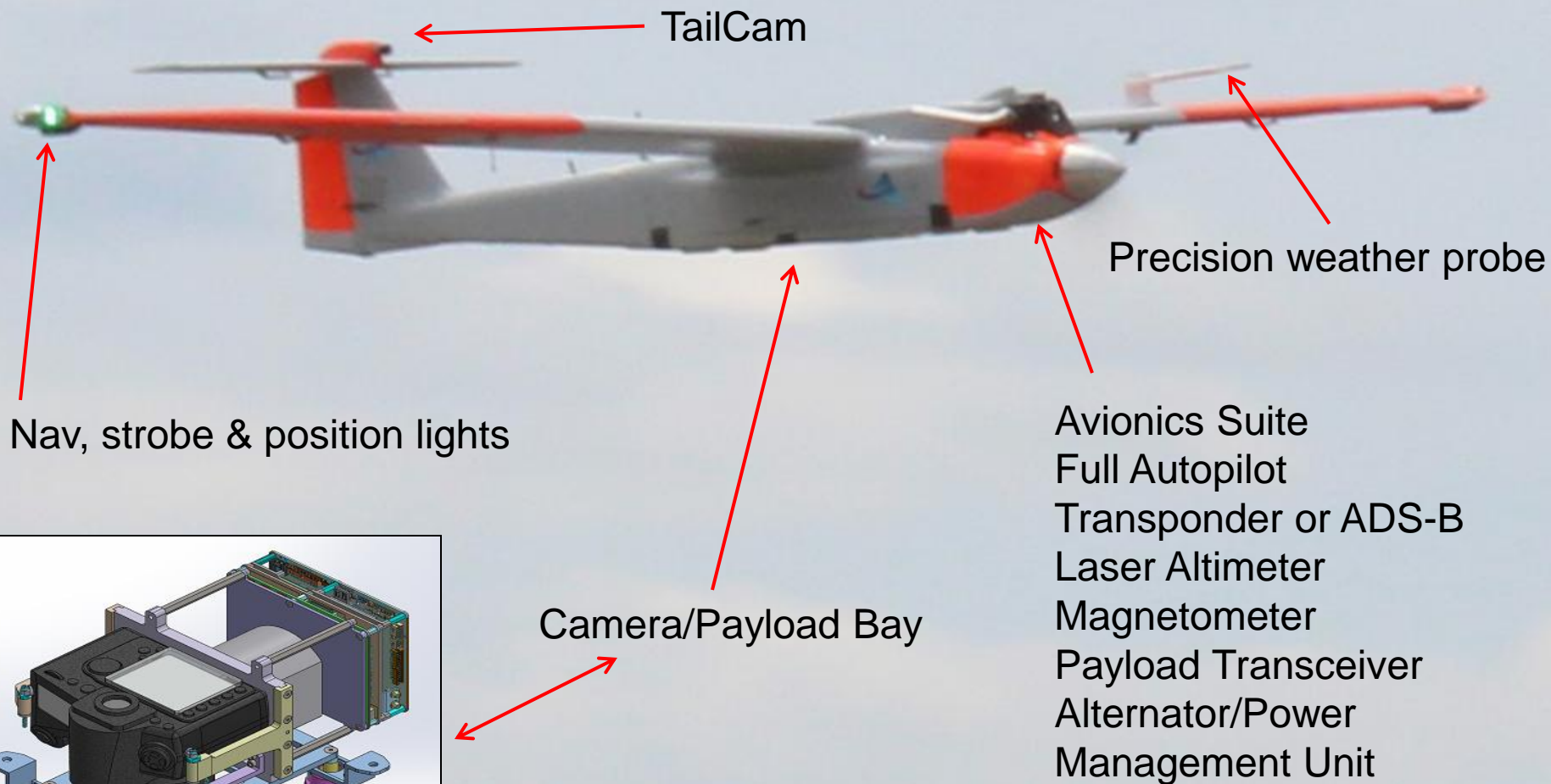
(typical Mission Package)

- The Recon System UAS is a complete, medium altitude long endurance mission system, including:



**The Bottom Line:** to be useful, a UAS is defined as a SYSTEM that includes everything required to conduct safe, legal and successful flight operations in civilian airspace – AND for the safe and efficient acquisition, production and dissemination of useful data products

# The RS-16 and RS-20 UAS™ are professional grade, beyond line of sight, long endurance Unmanned Aircraft Systems



**Modular design enables rapid integration and flight test of new sensors**

- The RS-16 carries up to 25 pounds of sensors for 12+ hours on 1.5 gallons of gasoline while providing 100 watts of continuous payload power
- The RS-20 carries up to 65 pounds of sensors



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# RS-16 and RS-20 Aircraft Specifications

RS-16				RS-20	
Wingspan	in/m	12' 11"	3.9	17' 3"	5.2
Max Gross Takeoff Weight	lbs/kg	85	39	175	80
Endurance	hrs	12+		12+	
Ceiling	ft/m	15,000	4,572	23,000	7,000
Max Speed	kts/kph	65	120	75	138
Best Cruise	kts/kph	55	101	55	101
Payload Mass (max)	lbs/kg	25	11	65	29
Payload Electrical	watts	100		400	
Payload Envelope					
Internal	in/mm	6 x 6 x 18.5"	150 x 150 x 470mm	10.75 x 10.75 x 34	273 x 273 x 875mm
External		Wing-mounted		Hard Points	
Payload Comms		Details on request		Details on request	
Protocol (typ)		IP-based		IP-based	
Launch		Pneumatic Catapult		Pneumatic Catapult	
Recovery		Belly Land, Pneumatic or VTOL		Belly Land, Pneumatic or VTOL	

- **Modular design enables rapid integration and flight test of new sensors**
- **AATI is currently expanding its fleet!**

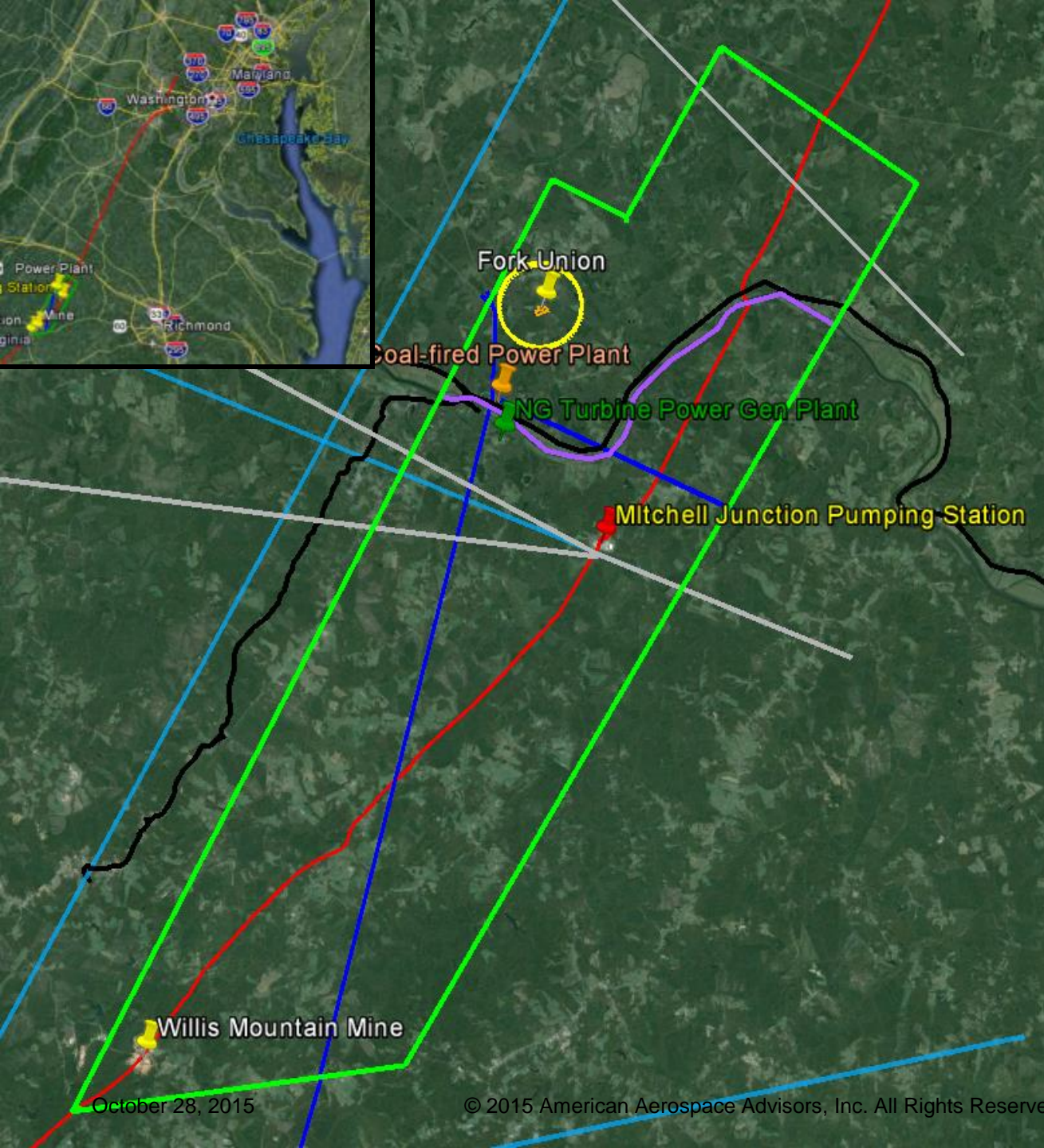


# Buckingham COA

## • 2014-ESA-133

- MAAP Test Site COA
- RS-16 UAS
- RS-20 UAS
- 185 Square Miles
- 3,000 ft ceiling

- **Pipeline: 28 mi**
- **Power Lines: 24+ mi**
- **Rail Lines: 13 mi**
- **River: 12 mi**
- **Open Pit Mine**
- **Coal Fired Power Plant**
- **NG Turbine Power Plant**
- **Ag Fields: ~50+ sqmi**

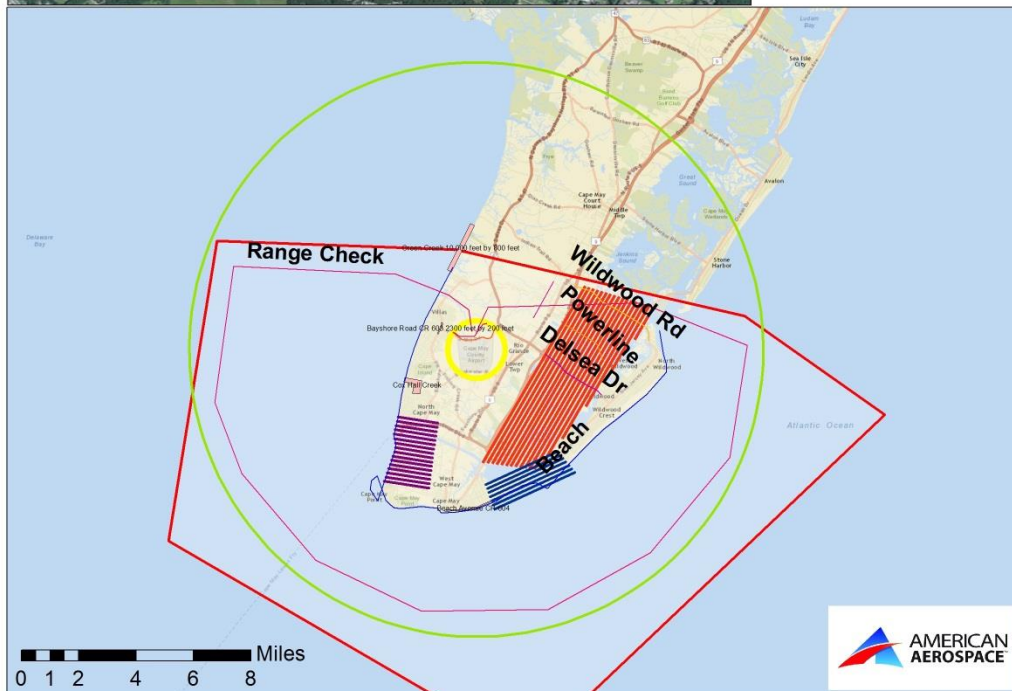
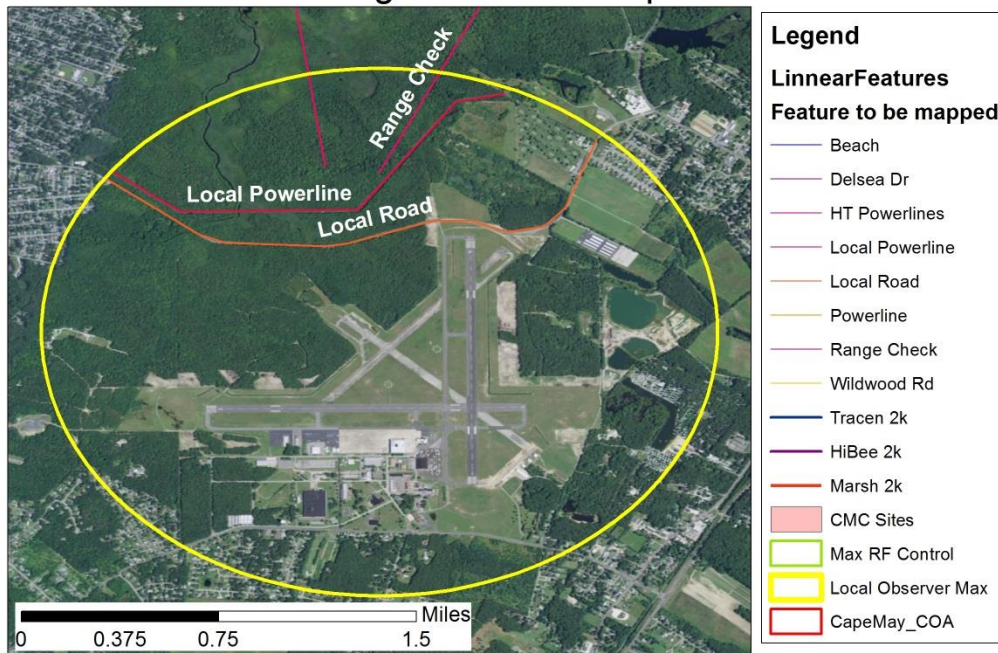


October 28, 2015

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All Figures Approximate

# KWWD Flight Plans for September 2015

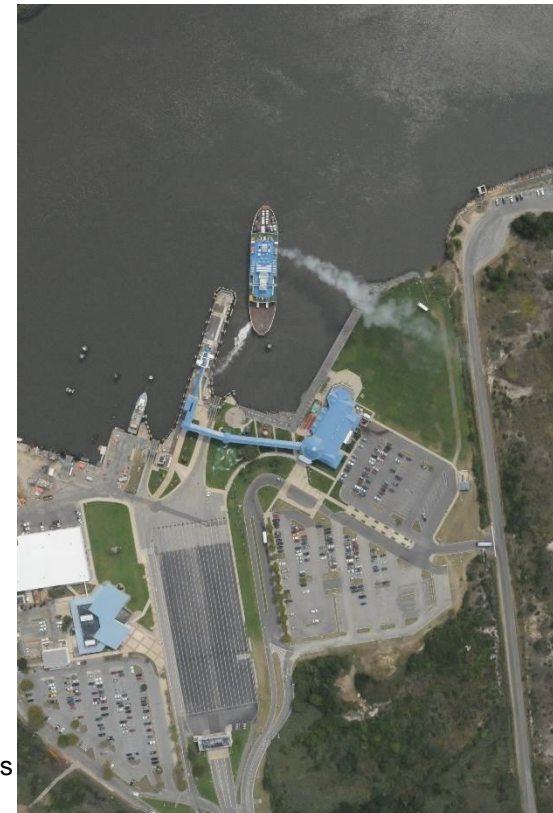


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## Campaign 00253 September 1-2, 2015

### Basic Mission Information:

- Total Flight Mission Timeframe: 2 days including set up and tear down
- Total Flight Time: 7 Hours
- Max Altitude: 6,500 Feet
- Max Range: 10 Nautical Miles
- Max Distance Offshore: 5.3 NM
- Total Distance Flown: Over 400 NM



Rights

# Autonomous Threat Detection System

ATDS prototype in field trials on Columbia patrol aircraft

ATDS is also fly on UAS

- Real-time threat detection and reporting during routine pipeline aerial patrol
- Initial focus on fixed wing manned aircraft – COTS technologies

## **ATDS Conop:**

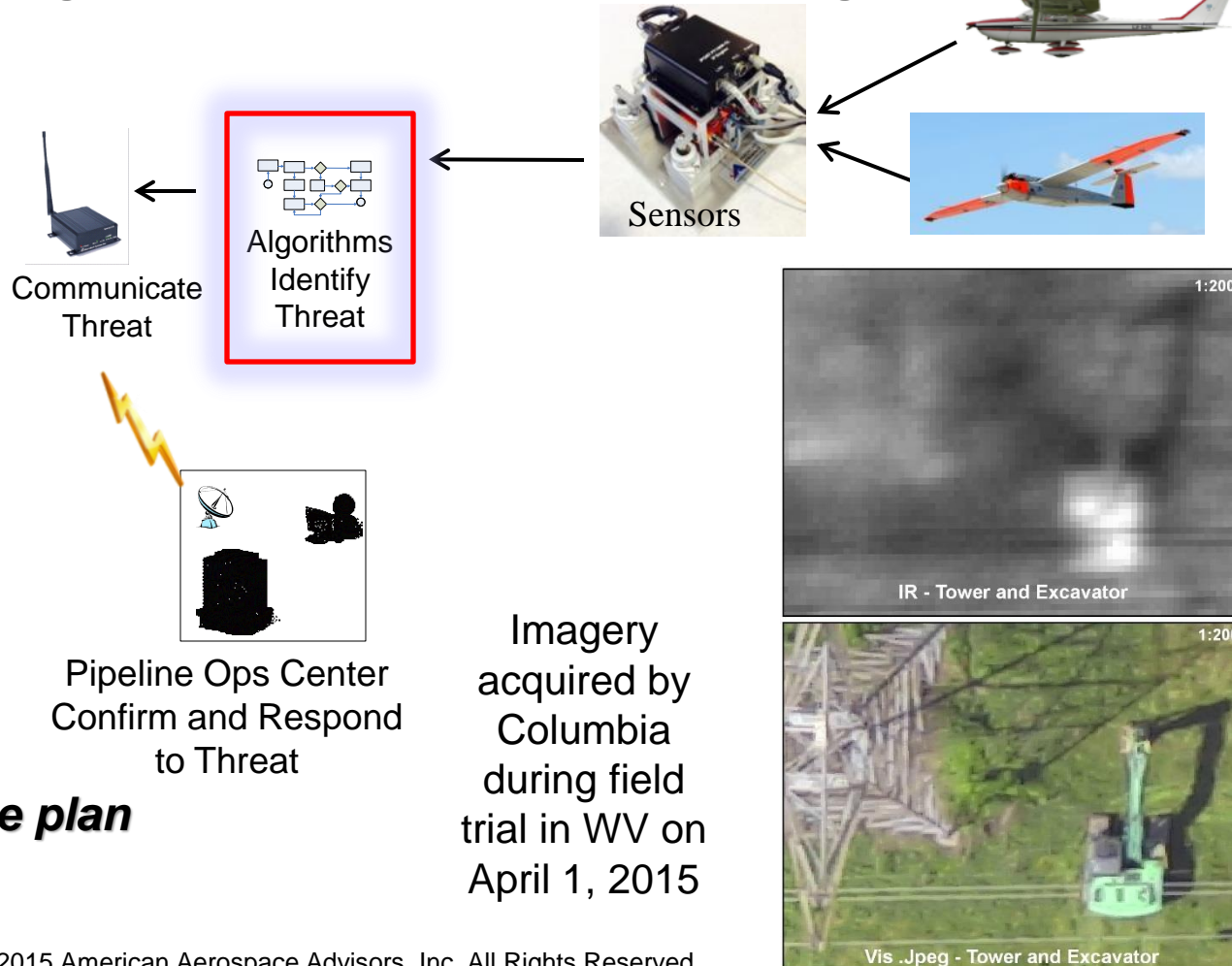
**Detect** – sensing & imagery collection

**Process** - data processing and analysis via algorithms

**Distribute** – communication

**Archive** – improved data management processes and predictive modeling

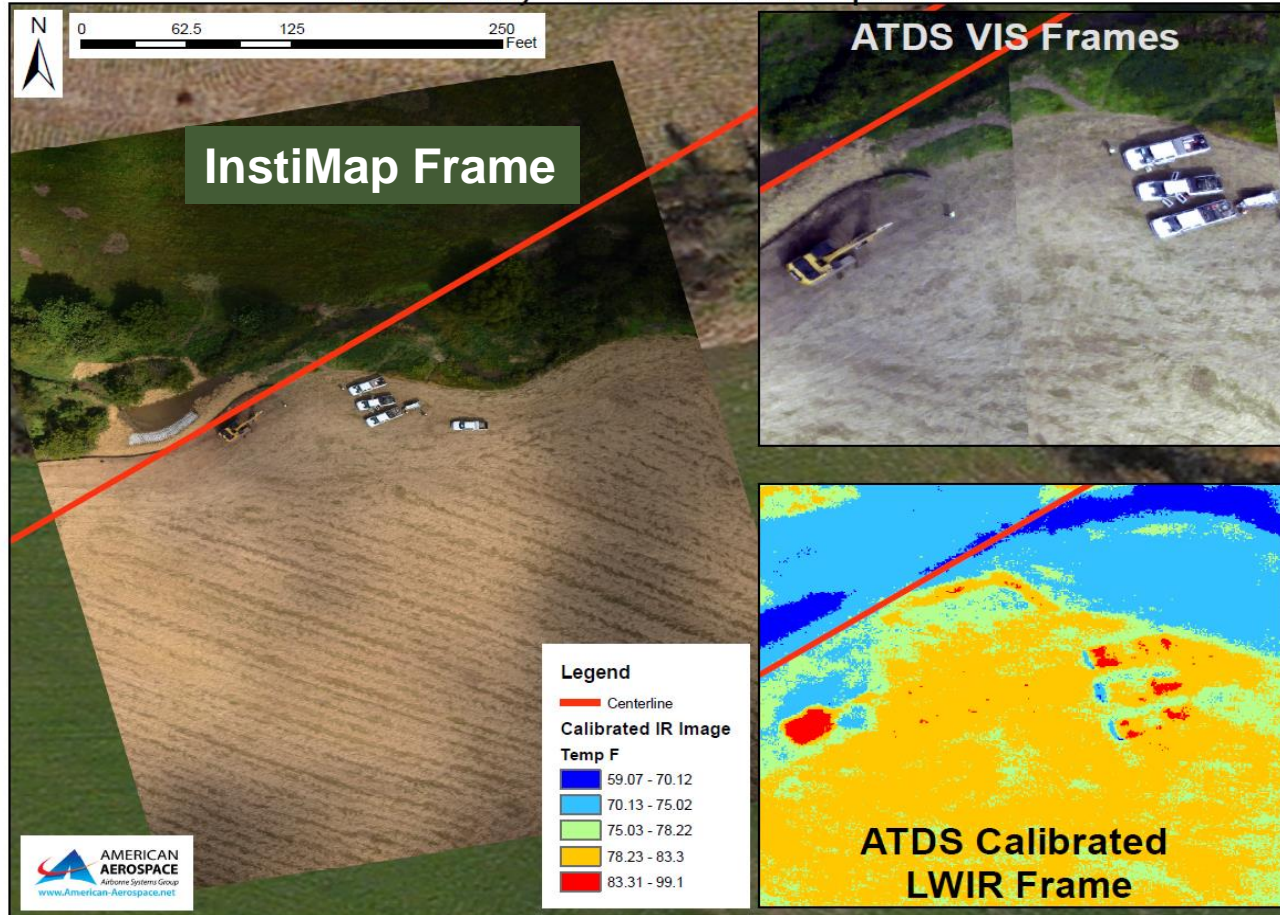
- ***Transition to UAS has always been in the plan***





# Pipeline Threat Detection

## Machinery Threats Near Pipeline



**The ATDS Sensor**  
Provides color imagery and calibrated infrared imagery.

The combination of the two datasets allow analysts to detect visually, or via heat signature (infrared), machinery located along a pipeline corridor that may pose a threat to the integrity of the pipe.

# InstiMaps™ System Background and Future

- Prototype in operation
  - High resolution imagery collection
  - Flies on manned & unmanned aircraft
- Present: rapid, automatic collection processing and dissemination of high resolution geo-located imagery
  - Pipeline Patrol
  - Emergency Response
  - Rapid Response Mapping and Mapping Products
- Future: addition of Thermal Sensing Capabilities Third Quarter 2015
  - Emergency Response Fire Mapping
  - Search and Rescue
  - Marine Mammal and others

## **The InstiMaps™ Mapping Sensor Payload**

Allows for collection of color geolocated imagery (up to 2 inch resolution at 1000 feet AGL) and generation of digital ortho photos, digital elevation and other 3-D models.



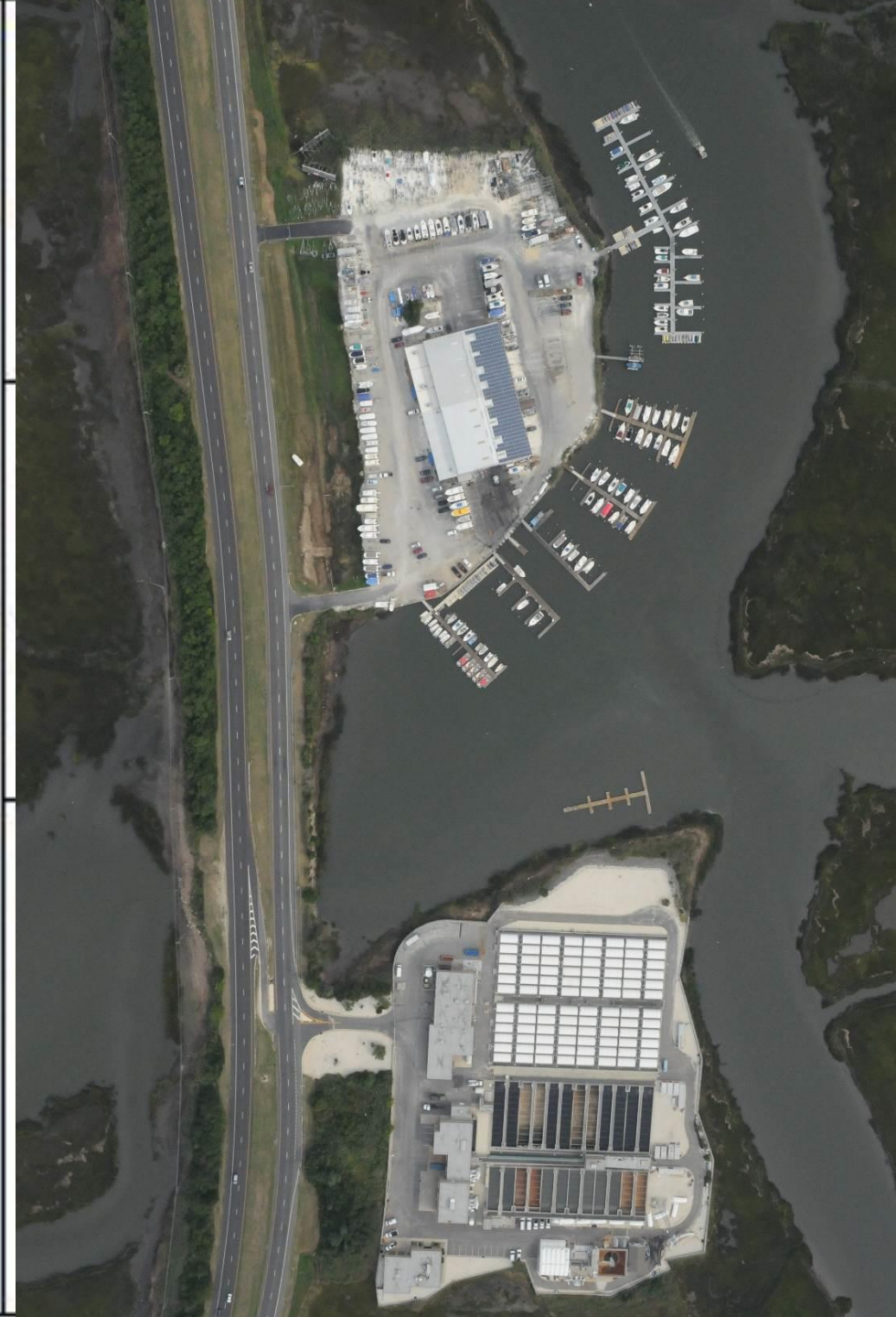










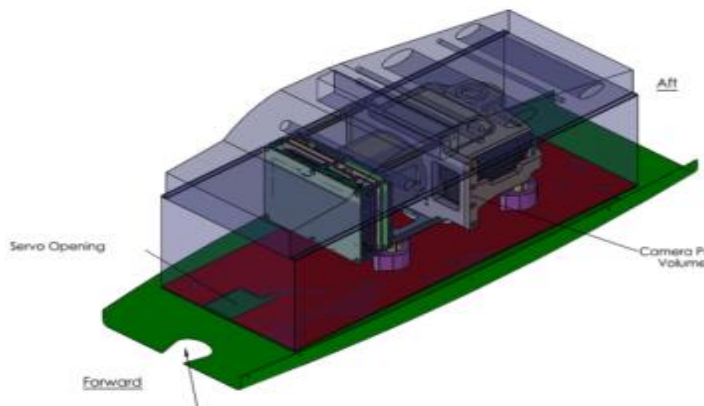




# The Direct Mapping Solution



- Direct Mapping Solution (DMS)
  - 36 MPx visible light (VIS) sensor – calibrated
- Overall Accuracy (stereo products)
  - 1 Pixel Horizontal Accuracy
  - 4 Pixel Vertical Accuracy
  - Without Ground Control Points
- Rapid production of survey-grade orthophotos, orthomosaics, Digital Elevation Models & Obliques
- Interoperable on Manned & Unmanned Aircraft





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# Pavement Surface Evaluations



**The DMS Mapping Sensor Payload**  
Allows for collection of very large scale (up to 1" pixel resolution) and spatially accurate (3 pixels) imagery that may be utilized to detect pavement wear and cracking etc.

**DMS One Square Mile Imagery of Airport Runway at 1" Resolution**



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# Additional Infrastructure Sensors



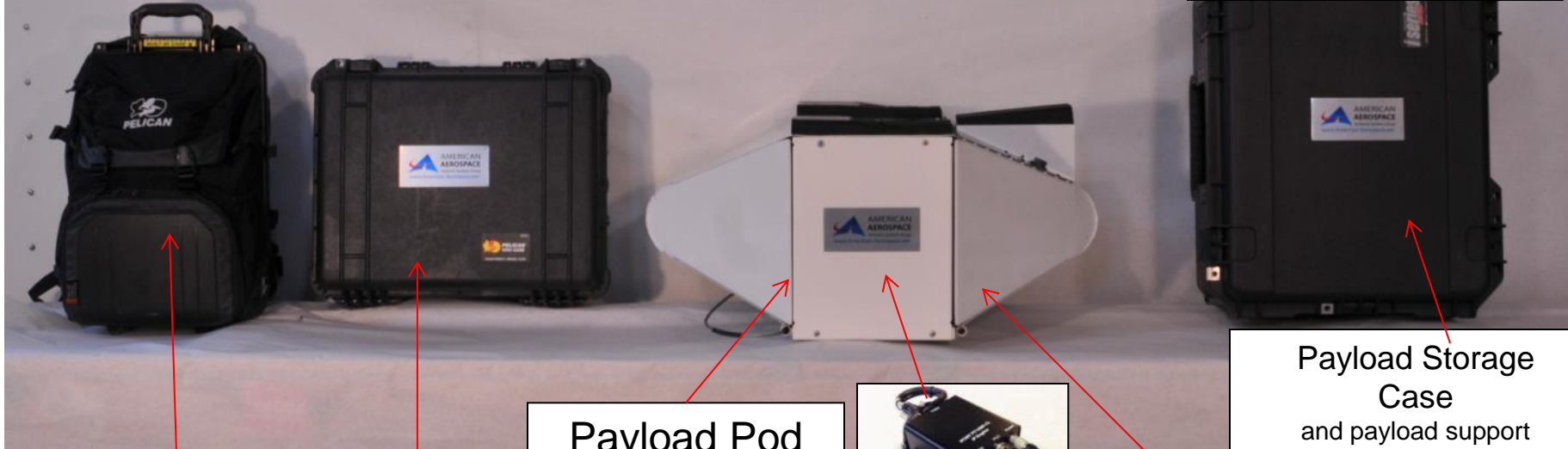
## **Princeton National Science Foundation Funded Gas Sensor**

Mounts on the wing of the UAS and flying in the low or medium troposphere is able to be tuned to detect and provide data of various types of gaseous and potentially toxic substances that may be leaking from pipelines and/or oil rigs etc.

# RAM Airborne Threat Detection System



ATDS is **“Interoperable”**  
same payload operates on both  
manned & unmanned aircraft



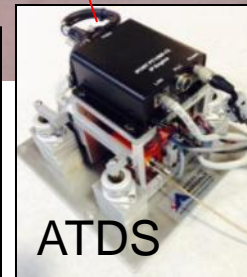
Threat  
Assessment  
Computer  
and support  
equipment

October 28, 2015

Avionics  
Case  
Fits in cargo  
compartment

## Payload Pod

- STC'd Pod fits any non-RG Cessna 172 and 182
- Columbia is flying ATDS and CMP



ATDS

Payload Storage  
Case  
and payload support  
equipment

## Mapping Payload





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# ***Q and A***

